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(71) Applicant: Hitachi, Ltd.
Chiyoda-ku, Tokyo (JP)

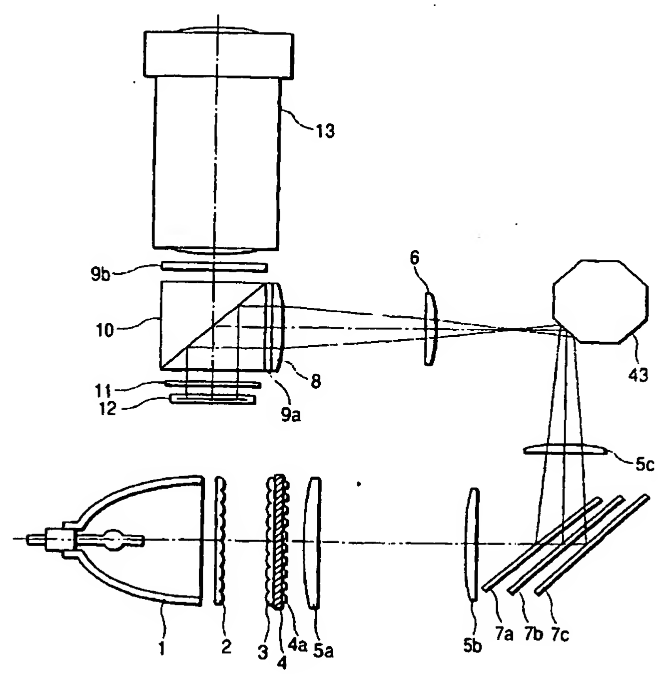
(72) Inventor: Ouchi, Satoshi, c/o Hitachi Ltd., Int. Prop. Off.
Chiyoda-ku, Tokyo 100-8220 (JP)

(74) Representative: Calderbank, Thomas Roger et al
MEWBURN ELLIS
York House
23 Kingsway
London WC2B 6HP (GB)

(54) **Optical unit and image display device thereof**

(57) A single plate type optical unit and display device to utilize light with high efficiency in a simple method is configured so a dichroic mirror separates light into a plurality of colors, and the plurality of colors of light reflected by the dichroic mirror are beamed onto a rotating multisurface element, the plurality of colors of light emitted from the rotating multisurface element are each beamed onto different locations on the display element, and by rotating the rotating multisurface element, the plurality of colors of light are moved in one direction along the display element, and a color image is beamed from a projection lens.

FIG. 1



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by mounting these components in an optical unit having an optical path from the light source 1 to the projection lens 13.

[0032] The embodiment when the direction from the light source 1 to the dichroic mirror group 7a, 7b, and 7c is the same as the direction from the reflecting rotating multisurface element 43 to the projection lens 13 is described next while referring to FIG. 7.

[0033] FIG. 7 is structural views showing the third embodiment of the optical unit of the present invention. Sections in the figure assigned with the same reference numerals are identical to the same sections in the embodiments of FIG. 1 and FIG. 3 through FIG. 5 so an explanation is omitted here.

[0034] The optical path between the light source 1 to the dichroic mirror group 7a, 7b, 7c is different from the optical path shown in FIG. 1 in that there is no second collimator 5b however the other components of the optical path are the same.

[0035] In the optical path from the dichroic mirror group 7a, 7b, and 7c to the reflecting rotating multisurface element 43 is different from the optical path shown in FIG. 1 in that there is no third collimator 5c, however this collimator 5c may also be used. Two types of converging lenses 6a, 6b are used in the optical path from the reflecting rotating multisurface element 43 to the PBS10. The structure from the PBS10 onwards is the same as shown in FIG. 1. The dotted line in FIG. 7 indicates the green light, while the dot-dash line indicates the optical axis of the green light. The optical axes of the red light and blue light are omitted but their optical axes can be shown as in FIG. 1.

[0036] In this embodiment, among the three (colors of) lights reflected from the dichroic mirror group 7a, 7b, and 7c, the light in the center, or in other words the green light is focused and converged on one surface of the reflecting rotating multisurface element 43. In this case, the red light and the blue light are beamed centered around the green light on the reflecting rotating multisurface element 43 so that each surface of the reflecting rotating multisurface element 43 can be made smaller compared to when the green light is converged onto other than the center of the reflecting rotating multisurface element 43.

[0037] Also in the present embodiment, the red light, green light and blue projected light can be emitted from the projection lens 13 on an optical axis approximately in parallel with the optical axis of the dichroic mirror group 7a, 7b, and 7c from the light source 1.

[0038] There is no restriction here on the collimator lens and these may be installed behind the dichroic mirror group 7a, 7b, and 7c. The particular features of the dichroic mirror group 7a, 7b, and 7c may also be interchanged such as by either of the combinations of RGB, BGR however, weak light wavelengths should have priority according to the output of the light source serving as the light source, in other words, the initial reflection method is satisfactory for reducing the permeance (transmittance) count.

[0039] The fourth embodiment of the present invention is described next while referring to FIG. 8.

[0040] FIG. 8 is a structural view showing the fourth embodiment of the optical unit of the present invention. In this figure, after the light from the light source 1 has passed through the first collimator lens 5a and the second collimator lens 5b, the light is input to the first light valve 46. The polarization direction of the light is aligned by the PBS45a, PBS or the full reflecting prism or the full reflecting mirror 45b, or the $\lambda/2$ wavelength plate 4b while reflecting from the internal surface of the first light valve 46 and advancing, and is input for example as S polarized light to the second light valve 44. The S polarized light input to the second light valve 44 advances while reflecting from the internal surfaces of the second light valve 44 and the red light, green light and blue light are respectively reflected from the dichroic mirror group 7a, 7b, and 7c and are input to the reflecting rotating multisurface element 43. The red light, green light and blue light reflected from the reflecting rotating multisurface element 43 pass through the first converging lens 6a, second converging lens 6b, third convergence lens 6c and polarizing plate 9a and are input to the PBS10. The optical path from there onwards is the same as in the case of FIG. 1.

[0041] A color image can also be displayed on the screen in this embodiment. Also in this embodiment, light projected from the projection lens 13 can be emitted on an optical path in a direction perpendicular to the optical axis of light from the dichroic mirror group 7a, 7b, and 7c and light source 1.

[0042] In this embodiment, the light is formed into S polarized light by means of the PBS45a and the fully reflecting prism 45b so that a line or streak can be obtained between the S polarized light emitted from S polarized light emitted from the PBS 45A and the S polarized light emitted from the fully reflecting prism 45b. When these two S polarized lights pass through the second light valve 44, the line or streak occurring among the two S polarized lights is eliminated by reflection of the two S polarized lights internally in the second light valve 44. If not concerned with the line or streak occurring among the two S polarized lights, then the second light valve 44 for aligning the S polarized light may be omitted.

[0043] Insertion of the PBS45a causes the width of the light of the light valve 46 to enlarge in one direction to approximately twice the original size so the shape of the output beam opening of the light valve 44 can easily be made to a similar shape (band rectangular shape) as the scroll band shape on the display element. Also the input opening shape of the light valve 46 can be designed to a shape (for example, an approximately square shape) to match the light spot shape, so that light loss can be limited and the light can easily be extended to a rectangular shape and extremely good efficiency obtained. The output light beam opening of the light

[0053] The red light, green light and blue light reflected at this display element 12 and polarized into P polarized light, passes the PBS10 and is input to the projection lens 13. In this embodiment, the direction of the light emitted from the projection lens 13 is approximately parallel with the direction of light emitted from the light source 1, and faces the opposite direction.

[0054] In the embodiments in FIG. 10 through FIG. 12, the transmissible rotating polygonal mirror 47 rotates clockwise (direction of arrow A) as seen in the drawing.

[0055] In FIG. 10, the red light, green light and blue light reflected by the dichroic mirror group 7a, 7b, 7c on mutually different optical axes, are input to one surface of the transmissible rotating polygonal mirror 47, pass through the transmissible rotating polygonal mirror 47, and after being emitted from a surface facing the transmissible rotating polygonal mirror 47, these optical axes intersect and are input to the condenser lens 8.

[0056] In FIG. 11, the transmissible rotating polygonal mirror 47 is rotated clockwise in the case of FIG. 10, and the red light input to one surface, and the green light and blue light input to the next surface, and the respective red light, green light and blue light pass the transmissible rotating polygonal mirror 47, the red light is emitted from a surface different from the surface facing the one surface (of the multisurface element 47), the green light is input from the next surface, and emitted from a surface facing that surface, the blue light is input from the next surface, and emitted from a surface different from the surface facing that one surface. In this embodiment, the green light and blue light input from different surfaces, are emitted from different surfaces and after intersecting, are input to the PBS10.

[0057] In FIG. 12, the red light is input to one surface of the transmissible rotating polygonal mirror 47, and the green light and blue light input from the next surface, and the red light, green light and blue light respectively pass the transmissible rotating polygonal mirror 47. The red light is output from the surface facing the next surface, the green light is output from the surface facing the one surface, and the blue light is output from the surface facing the next surface. After the red light and blue light output from the surface facing the next surface have intersected, they pass the condenser lens and are input to the PBS10.

[0058] In the embodiments from FIG. 10 through FIG. 12, at least two of the red light, green light and blue light intersect after being output from the transmissible rotating polygonal mirror 47.

[0059] In this embodiment, any material capable of permeating light can be used as the material for the transmissible rotating polygonal mirror 47. Also, the number of surfaces of the transmissible rotating polygonal mirror 47 is not limited to eight surfaces and any polyangular shape can be utilized if having three or more sides. There are further no restrictions on the size of the transmissible rotating polygonal mirror 47.

[0060] The invention as described above can irradiate a respective plurality of colors on different locations on one display element by utilizing a dichroic mirror group to separate and reflect light into a plurality of colors, and a rotating multisurface element to change the direction of this plurality of colors; furthermore, the locations irradiated (or beamed upon) on the display element by the plurality of colors can be sequentially changed in one direction by rotating the rotating multisurface element, so that a color image can be obtained using one display element that further has a simple structure.

[0061] Also in this invention, the light from the light source is separated into a plurality of colors and this separated plurality of light colors can be irradiated with good efficiency upon a display element so that the utilization efficiency of the light is good.

[0062] In this invention, only one rotating multisurface element is used so that the positioning of the plurality of light colors irradiated upon the display element is simple.

[0063] In this invention therefore, as described above , an optical unit having a simple single plate type structure can be obtained. An optical unit having good light utilization efficiency can be obtained. Further, an optical unit having good simple positioning of the plurality of colors on the display element can also be obtained.

Claims

1. An optical unit comprising a light source, an image display element to form an optical image according to an image signal output from the light emitted from said light source, a color separator means for separating the light emitted from said light source into a plurality of light colors, a rotating multisurface element input with a plurality of light colors emitted by said color separator means for changing the respective optical axis direction and beaming saidplurality of light colors onto different locations on said display element while scrolling the light beam in one direction, and a projection device for projecting light emitted from said image display element as a color image.

2. An optical unit according to claim 1, wherein said color separator means is comprised of a dichroic mirror or a dichroic prism and reflecting mirror.

3. An optical unit according to claim 1, wherein of said plurality of light colors emitted from said rotating multisurface element, two of said light colors are input to said image display element after the optical paths of said two light colors intersect.

4. An optical unit according to claim 1, wherein said rotating multisurface element is a reflecting rotating multisurface element, a plurality of said light colors irradiate upon the surface of said reflecting rotating

mirror, said third dichroic mirror or reflecting mirror, and along with beaming said first, said second and said third color light onto different locations on said image display element, to scroll in one direction along the locations beamed upon by first, said second and said third color light, and a projection device to project light emitted from said image display element as a color image.

16. An optical unit according to claim 15, wherein a polarized beam splitter for aligning the polarizing direction of light from said optical pipe is installed downstream of said light pipe.

17. An optical unit according to claim 16, wherein other light pipes are installed downstream of said polarized beam splitter.

18. An optical unit comprising a light source, an image display element for forming an optical image according to an image signal output from the light emitted from said light source, a first array lens for forming a plurality of secondary light source images from said light source, a second array lens for converging each of the lens images of said first array lens, a polarized beam splitter to align the polarizing direction of the light, a first dichroic mirror to isolate a first color light from light inside said polarized beam splitter and control the optical axis direction of said first color light, a second dichroic mirror to isolate a second color light from among light inside said polarized beam splitter and control the optical axis direction of said second color light, a third dichroic mirror or reflecting mirror to control the optical axis direction of a third color light from among light inside said polarized beam splitter, a permeating rotating multisurface element to controllably pass light of the optical axis direction of each of said first, said second and said third color light beamed from said first dichroic mirror, said second dichroic mirror, said third dichroic mirror, and along with beaming said first, said second and said third color light onto different locations on said image display element, to scroll the locations beamed upon by first, said second and said third color light in one direction, and a projection device to project light emitted from said image display element as a color image.

19. An optical unit according to claim 18, wherein at least two color lights from among said first, said second and said third color lights reflected from the surface of said permeating rotating multisurface element are beamed onto said image display element after intersecting.

20. An optical unit comprising a light source, an image display element to form an optical image according to an image signal output from the light emitted from said light source, a color separator means for separating the light emitted from the light source into a plurality of light colors, a rotating multisurface element input with a plurality of light colors emitted by said color separator means for changing the optical path and beaming the plurality of light colors onto different locations on said display element while scrolling the light beam in one direction , and a projection device to project light emitted from said image display element as a color image;

wherein said color separator means is comprised of a dichroic mirror or a dichroic prism and reflecting mirror;

of said plurality of light colors emitted from said rotating multisurface element, two of said light colors are input to said image display element after the optical paths of said two light colors intersect;

said rotating multisurface element is a reflecting rotating multisurface element, a plurality of said light colors irradiate upon the surface of said reflecting rotating multisurface element, and the reflected light from said reflecting rotating multisurface element irradiates onto said image display element and;

after the light from the light source passes through an integrator element, said light irradiates said color separator means, and among the plurality of said light colors irradiated onto said image display element, at least one light shape resembles the output beam opening of said integrator element or the shape of the lens cells and, a convergence optical system is installed on the optical path downstream of said rotating multisurface element, and a rectangular light image with a shape similar to the shape of each cell in said image display element is converged onto said image display element

21. An image display device comprising:

an optical unit having a light source, an image display element to form an optical image according to an image signal output from the light emitted from said light source, a color separator means for separating the light emitted from said light source into a plurality of light colors , a rotating multisurface element input with a plurality of light colors emitted by said color separator means and changing the respective optical axis direction and beaming said plurality of light colors onto different locations on said display element while scrolling the light beam in one direction, and a projection device to project light emitted from said image display element as a color image;
an image processor circuit; and
a power supply.

FIG. 1

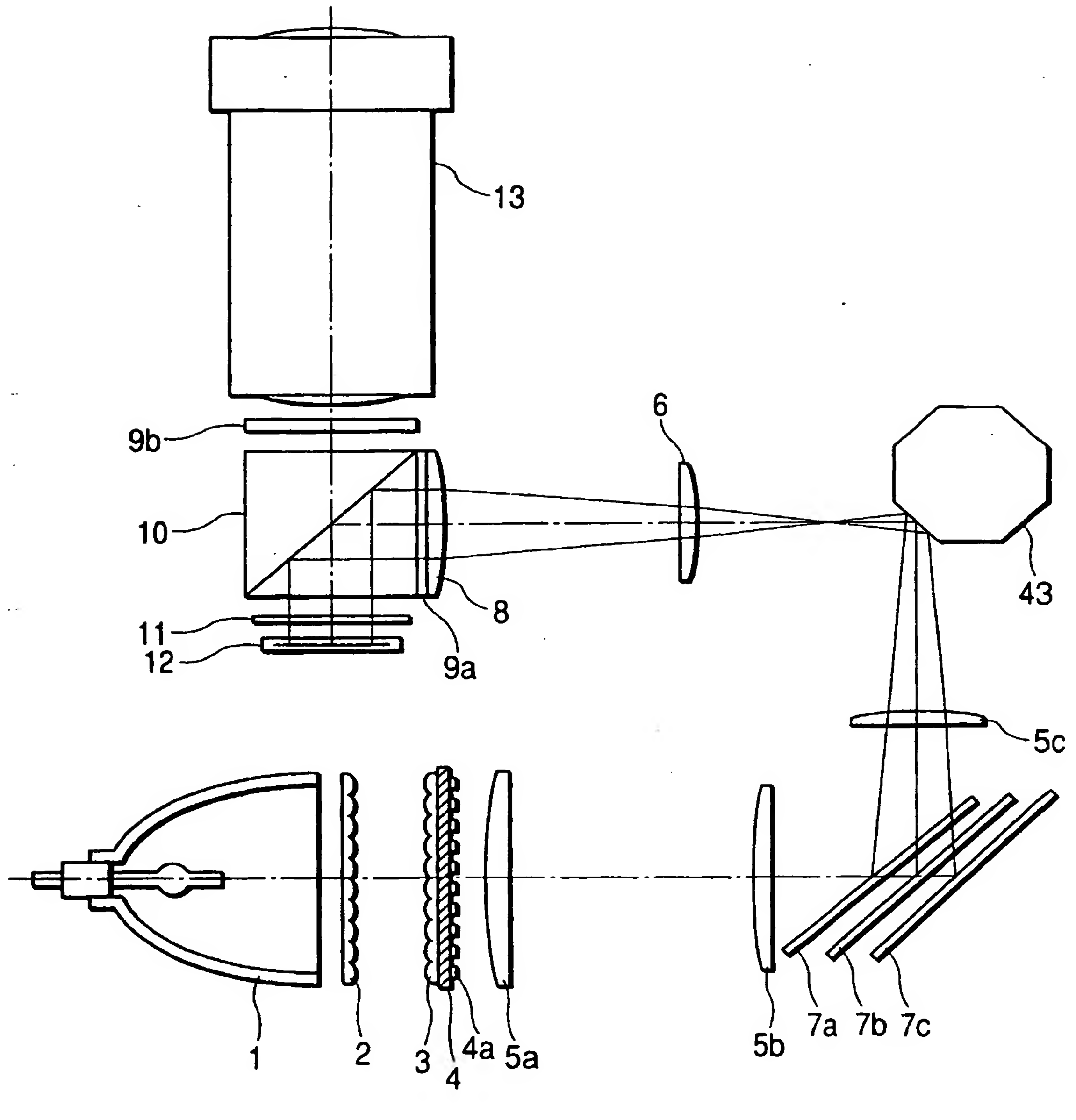


FIG. 3A

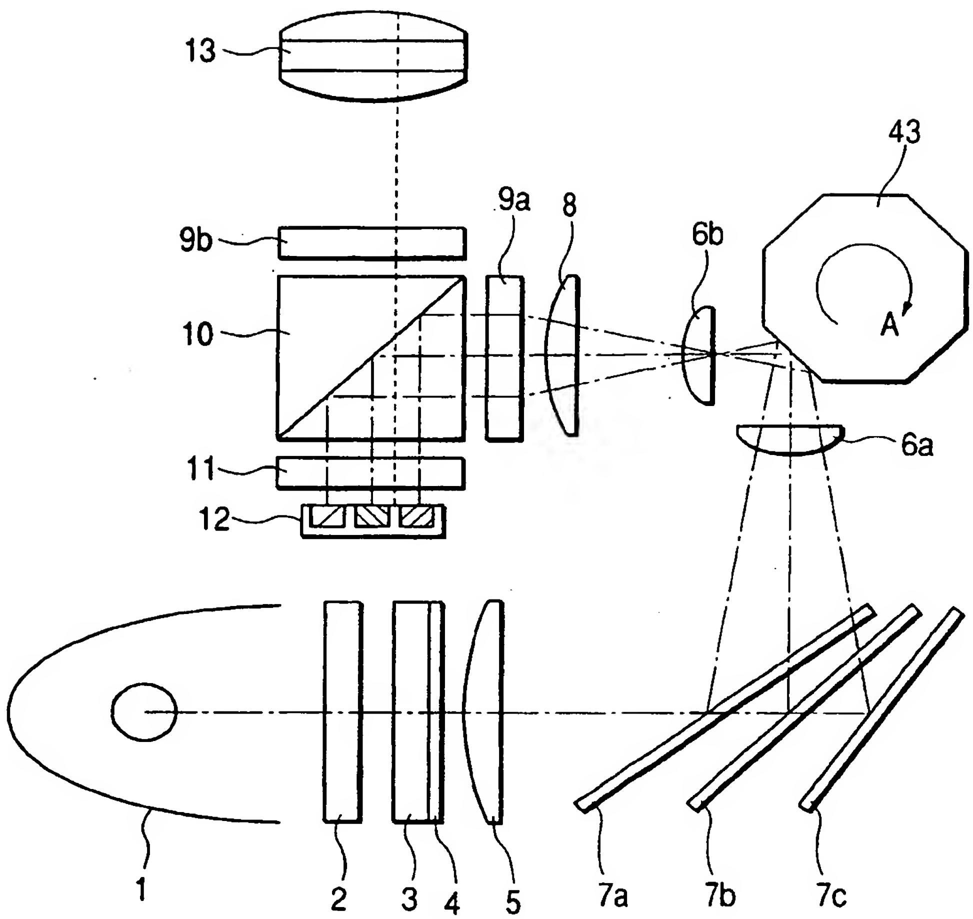

13
43
9a
8
6b
9b
10
A
11
6a
12
1
2
3
4
5
7a
7b
7c

FIG. 3B

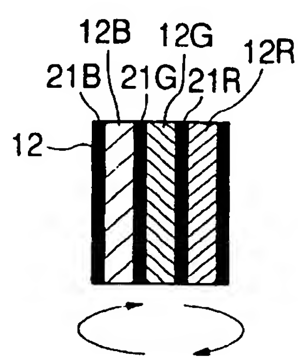

12B
12G
12R
21B
21G
21R
12

FIG. 5A

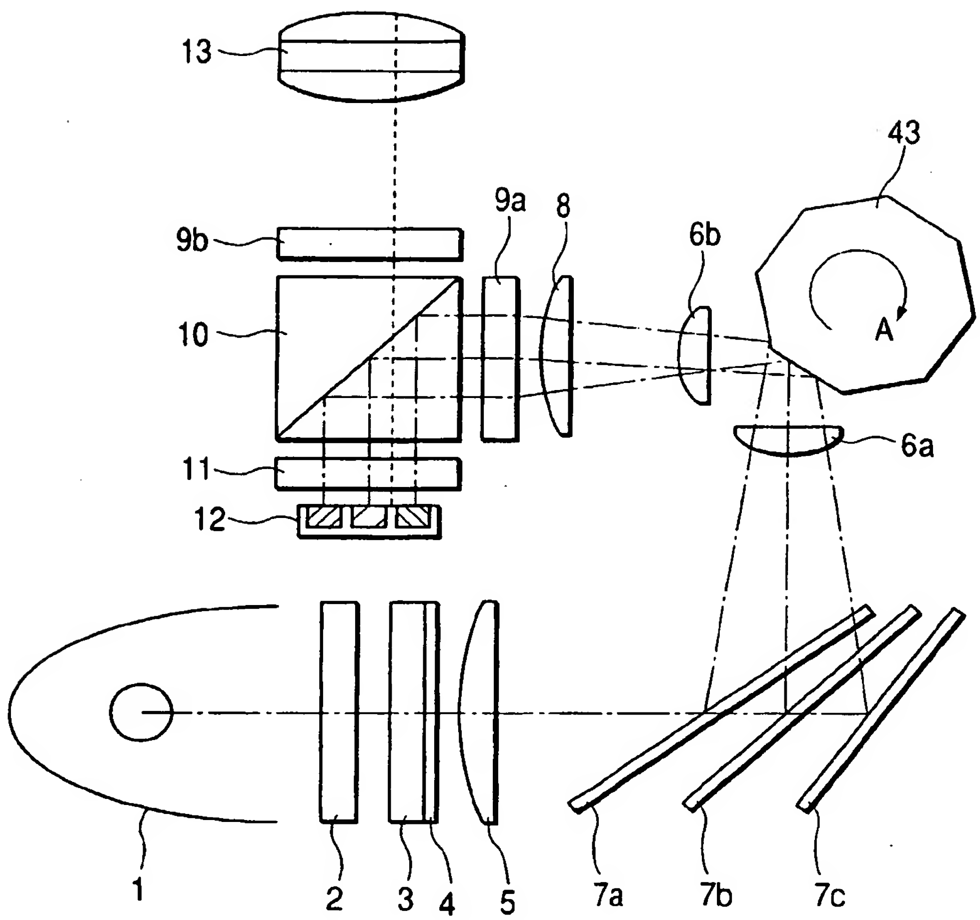

13
43
9a
8
6b
9b
10
A
11
6a
12
1
2
3
4
5
7a
7b
7c

FIG. 5B

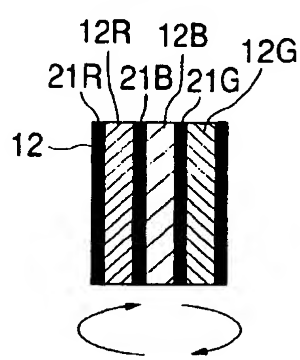

12R
12B
12G
21R
21B
21G
12

FIG. 7

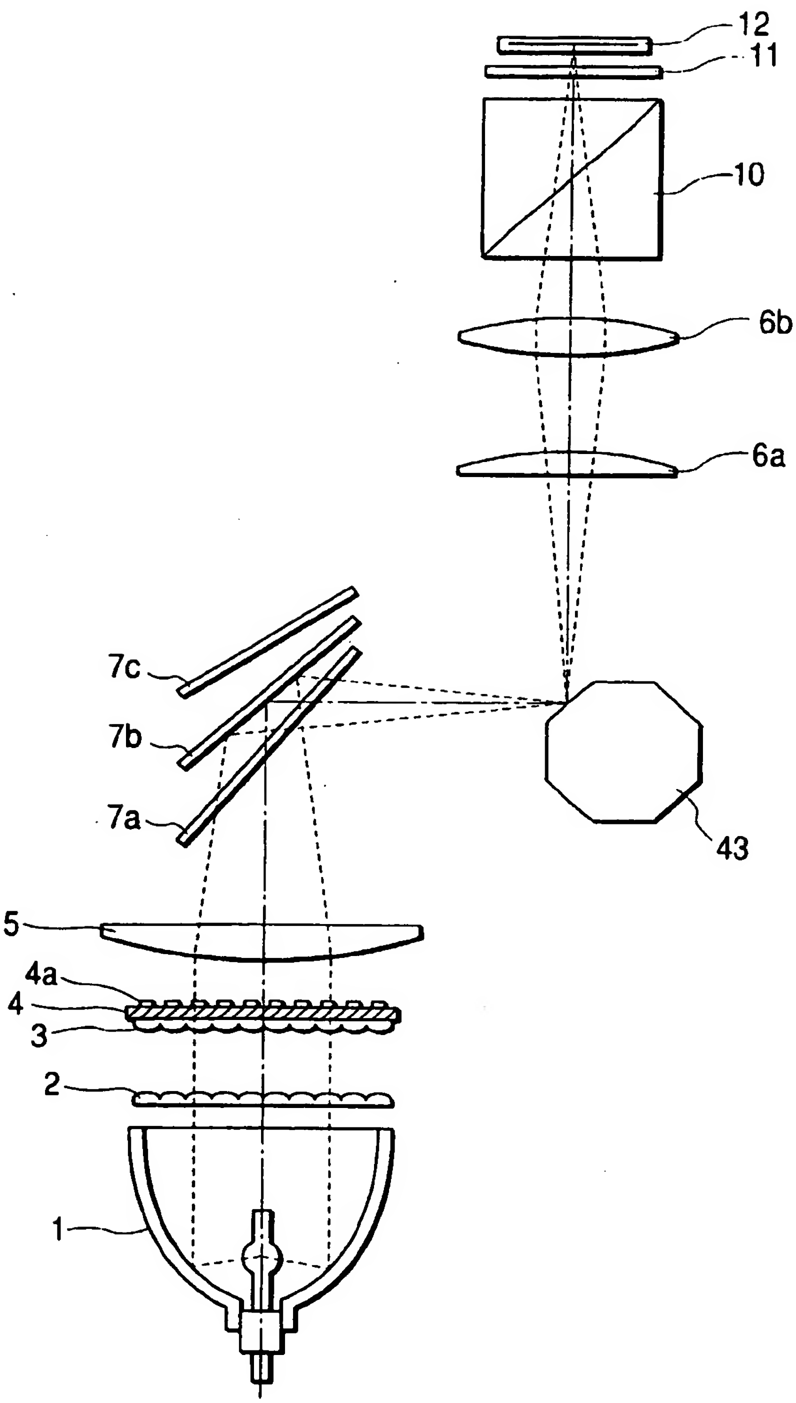


FIG. 9

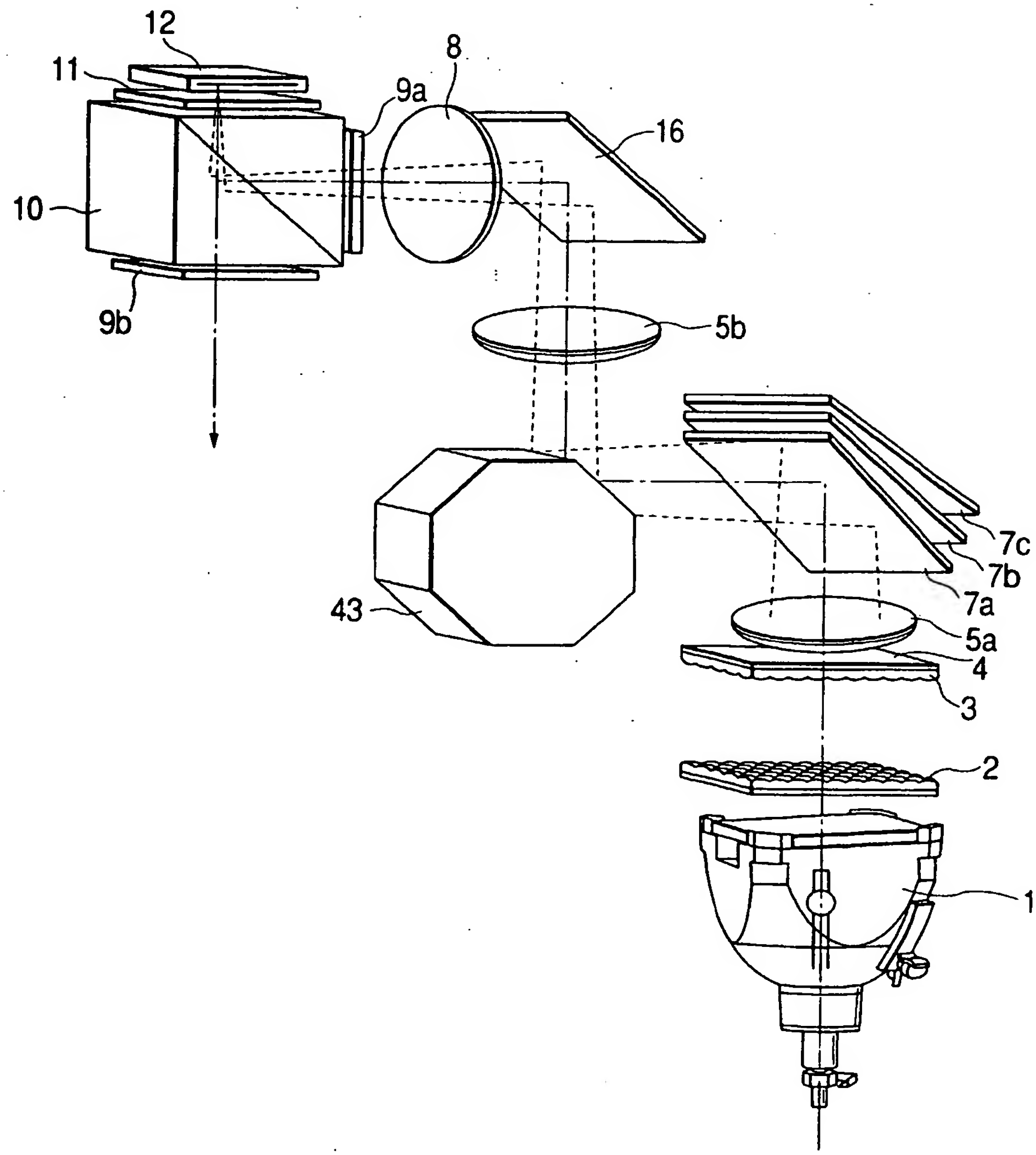


FIG. 11A

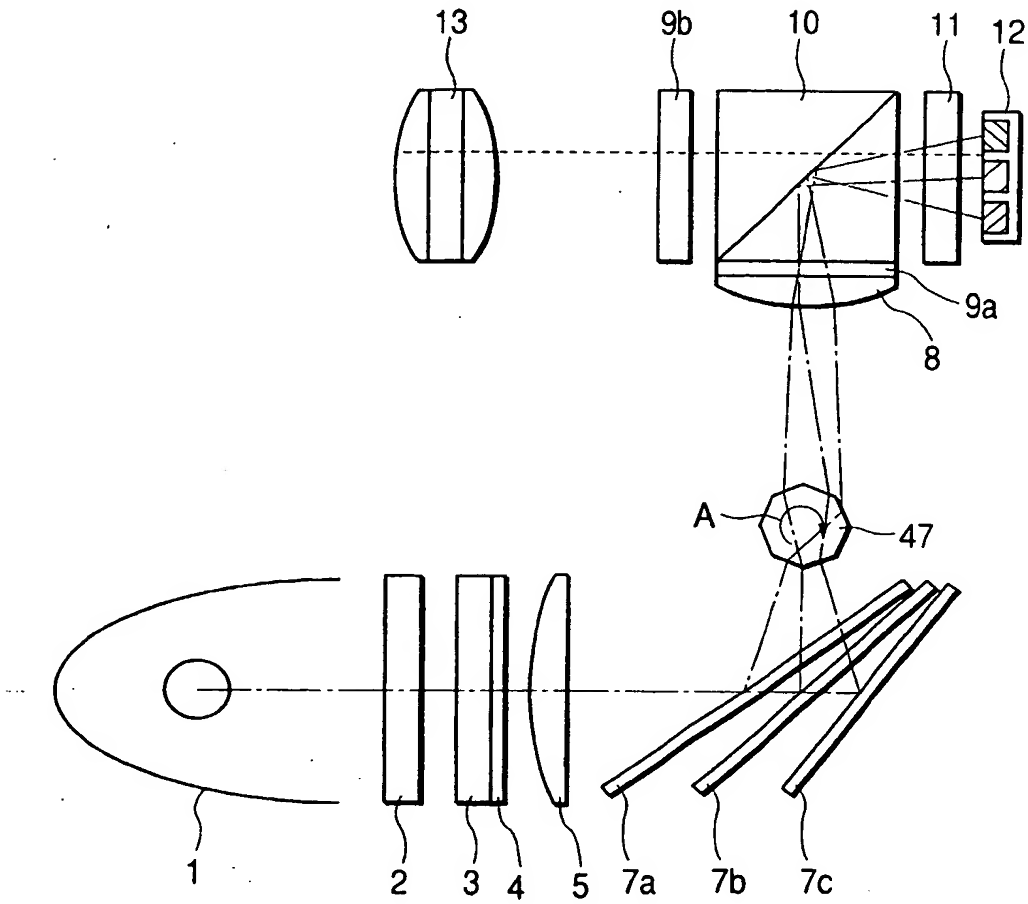
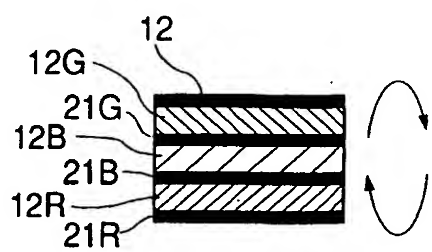


FIG. 11B



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(72) Inventor: Ouchi, Satoshi, c/o Hitachi Ltd.,
Int. Prop. Off.
Chiyoda-ku, Tokyo 100-8220 (JP)

(74) Representative: Calderbank, Thomas Roger et al
Mewburn Ellis LLP
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23 Kingsway
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(54) Optical unit and image display device thereof

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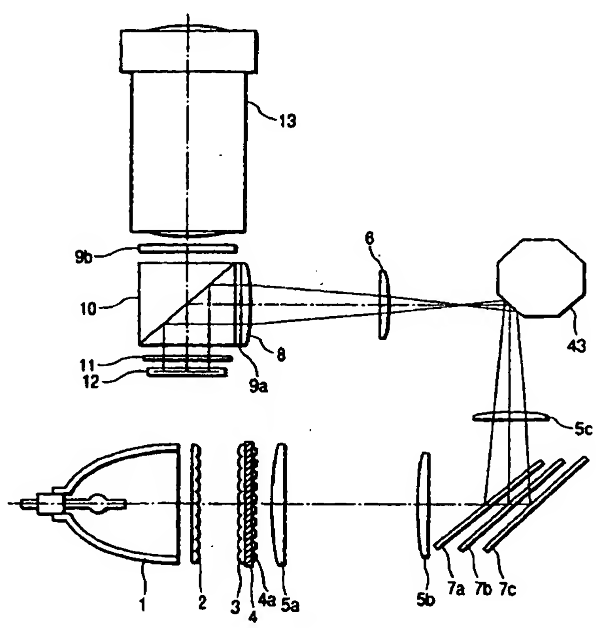
FIG. 1



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